

Vanilla bahiana Hoehne and *Vanilla pompona* Schiede (Orchidaceae, Vanilloideae): two new records from Maranhão state, Brazil

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Abstract

We present here the first records of *Vanilla bahiana* and *Vanilla pompona* from Maranhão state, northeastern Brazil. Both species were collected in a gallery forest, in areas of Cerrado vegetation at Caxias municipality. This work contributes with knowledge on the geographical distribution of the species in northeastern Brazil.

Key words

Cerrado vegetation; Neotropics; orchids.

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Introduction

Orchidaceae is the most representative monocot family in terms of number of species. The family currently has ca 27,000 identified species and 736 genera distributed worldwide, with this number increasing every year (Gov-aerts 2014, Chase et al. 2015). Brazil has ca 10% of that amount, that is, 2499 species (1599 endemic/ca 64% of the total) which are distributed in ca 220 genera (28 endemic/ca 13% of the total) (BFG 2015, Brazilian Flora 2017).

Pabst and Dungs (1975, 1977) reported only 10 species from the Brazilian state of Maranhão. Silva et al. (1999) reported 103 orchid species in the region, distributed over 48 genera. More research on the Orchida-

ceae has been carried out in Maranhão after the study conducted by Silva et al. (1999), and currently 122 species and 53 genera of orchids (Brazilian Flora 2017) are reported to the state.

Vanilla Plumier ex Miller has pantropical distribution and encompasses ca 100 terrestrial, hemiepiphytic, or occasionally epiphytic species, which can grow up to ca 25 m in length (Cameron 2003, Soto-Arenas 2003, Soto-Arenas and Cribb 2010, Soto-Arenas and Dressler 2010). The flowers of *Vanilla* species usually last less than 12 h open; they can be white, greenish white, beige, or even yellow; and yield pod-like fruits. Some of the species are grown for vanillin, which is obtained from their mature fruits. Species of *Vanilla* occur in tropical and subtropi-

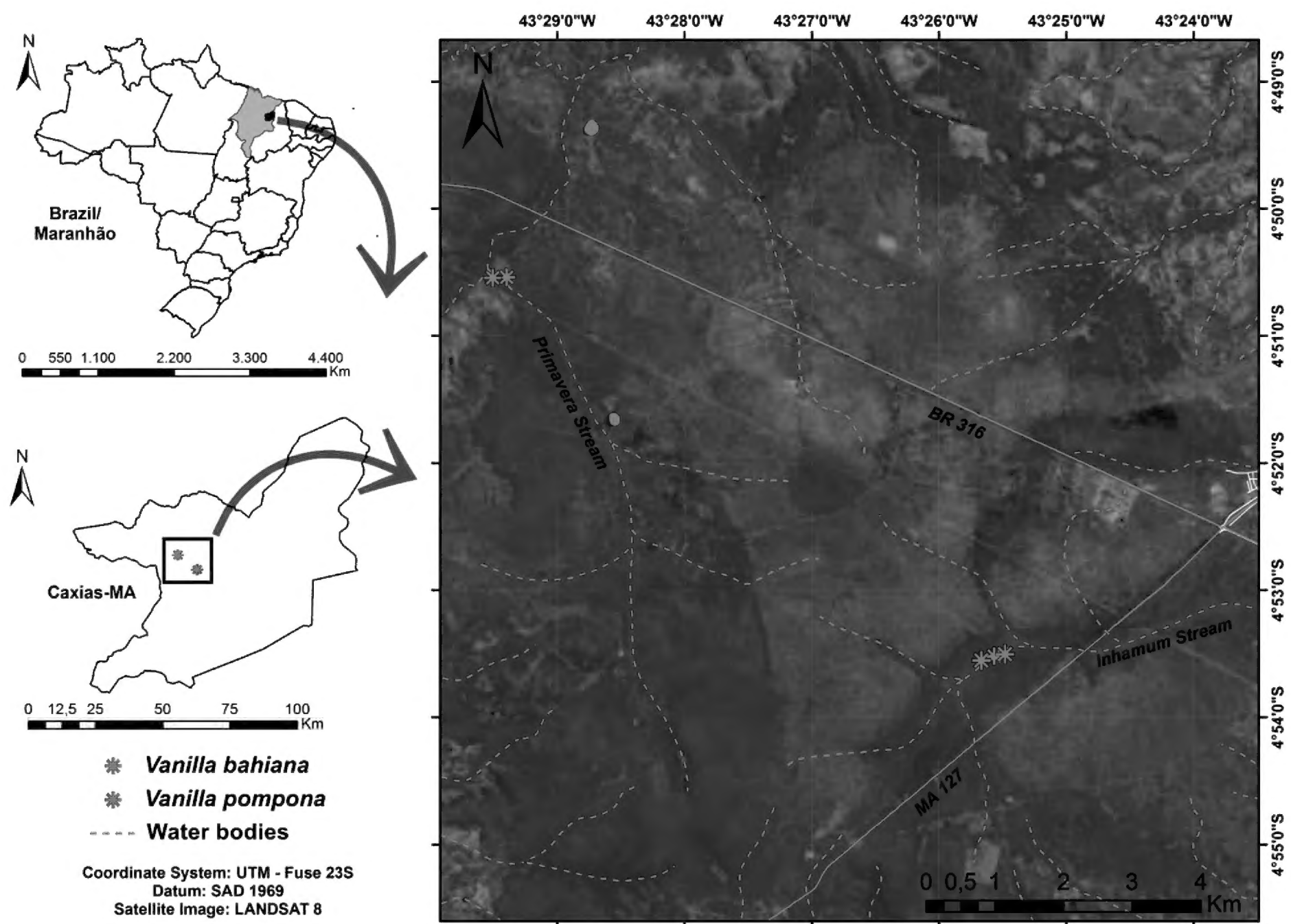


Figure 1. Area where *Vanilla bahiana* and *V. pompona* were collected.

cal regions of Africa, Asia, and America; it is absent in Australia. Most species are found in tropical America, followed by southeastern Asia, Africa, and islands in the Indian and Pacific Oceans (Cameron 2003, Soto-Arenas 2003, Soto-Arenas and Cribb 2010, Soto-Arenas and Dressler 2010, Pansarin et al. 2012, Chase et al. 2015). A total of 37 species of *Vanilla* occur in Brazil (Brazilian Flora 2017), including the newly discovered *Vanilla arcuata* Pansarin & M.R. Miranda (Pansarin and Miranda 2016), *V. capixaba* Fraga & D.R. Couto, and *V. paulista* Fraga & Pansarin (Fraga et al. 2017). Ten of those species are found in the northeast region of the country (Sanbim and Chiron 2015, Brazilian Flora 2017).

Among the species previously known from the state of Maranhão are *Vanilla mexicana* Mill., *V. palmarum* (Salzm. ex Lindl.) Lindl., and *V. planifolia* Jacks. ex Andrews (Brazilian Flora 2017). Records of *V. bahiana* Hoehne and *V. pompona* Schiede are the first from the state and extend the ranges of both species.

Methods

The Municipal Environmental Protection area of Inhamum (APA Inhamum) and the Primavera town are located in the municipality of Caxias, state of Maranhão, Brazil, both areas with gallery forests included in areas of the Brazilian Cerrado (Fig. 1). The APA Inhamum (04°53'30" S, 043°24'53" W; ca 3500 ha) is located in the

municipality of Caxias, in eastern Maranhão, Brazil (Fig. 1). The APA Inhamum is covered primarily by Brazilian Cerrado (Brazilian savanna), with 2 distinct types of vegetation (shrubby-arboreal and grassland) on the flatter terrain, with stands of buriti palms (*Mauritia flexuosa* L. f. Arecaceae) associated with watercourses, in depressions (gallery forests) (Neres and Conceição 2010). A town, Primavera (04°50'32" S, 43°29'29" W) (Fig. 1), is located approximately 8 km from the APA Inhamum and has forest fragments, including gallery forest, with the same characteristics as inside the protected area. Fieldwork in the gallery forests was carried out between December 2015 and December 2016 as part of the project "Orchids from Maranhão: taxonomy, pollination systems, and in vitro propagation" (Universal Announcement FAPEMA 0043/2015).

Collected specimens were identified following Hoehne (1950), Soto-Arena and Dressler (2010), Pessoa and Alves (2012, 2015), BFG (2015), and the online databases Brazilian Flora (2017), Tropicos (2017), and SpeciesLink (2017), which were also used to determine the geographical distributions of the species. A specimen of each species of *Vanilla* was deposited in the HENAC herbarium (Federal University of Maranhão, Codó, Brazil) and in the MAR herbarium (Federal University of Maranhão, São Luís, Brazil). The herbarium acronyms follow Thiers (2017). Morphological descriptions, photographic plates, and the map with the collection

site of both species are provided, as is the taxonomic key to *Vanilla* species from Maranhão.

Plates were edited using software Adobe Photoshop CS5 v. 12.0 (Adobe Systems Incorporated). The distribution maps were prepared with information available on exsiccates from the SpeciesLink website (2017) and software QGIS 2.14.0 Essen (QGIS Development Team 2009), using the coordinate system UTM zone 23S, GCS South American Datum 1969. The Extent of Occurrence (EOO) and Area of Occupancy (AOO) were calculated using the Geospatial Conservation Assessment Tool GeoCAT (2017). The AOO was based on a defined cell width of 2 km. The conservation status was proposed following IUCN (2017) criteria. To estimate the geographical distribution of *V. bahiana* and *V. pompona* in Brazil and to verify the approximation of the reference values of AOO and EOO, 150 geographical occurrences of *V. bahiana* were used, and 18 of *V. pompona* present in the online database SpeciesLink (2017).

Results

New records. *Vanilla bahiana* BRAZIL. MARANHÃO: Caxias, Área de Proteção Ambiental Municipal do Inhamum (APA Inhamum), near the Inhamum stream (gallery forest), 04°53'31" S, 043°25'34" W, fl., 30-XII-2015, M.S. de Oliveira & E.O. Silva 02 (HENAC 151); *ibid.*, Primavera Stream (gallery forest), 04°50'32" S, 043°29'30" W, fl., 27-X-2016, M.S. de Oliveira & E.O. Silva 05 (HENAC 154); *ibid.*, fr., 31-XII-2016, M.S. de Oliveira; E.O. Silva & A.W.C. Ferreira 07 (HENAC 156) *Vanilla pompona* BRAZIL. MARANHÃO: Caxias, Área de Proteção Ambiental Municipal do Inhamum (APA Inhamum), gallery forest, Inhamum stream, 04°53'31" S, 043°25'34" W, fl., 13-VIII-016, M.S. de Oliveira 03 (HENAC 152); *ibid.*, fr., 31 November 2016, M.S. de Oliveira; E.O. Silva & A.W.C. Ferreira 06 (HENAC 155); *ibid.*, near to Sumidouro do Padre, 04°53'33" S, 043°25'41" W, fl., 16-VII-2016, M.S. de Oliveira & E.O. Silva 04 (HENAC 153). BRAZIL. MARANHÃO: Posto Indígena Pindaré (FUNAI Post Guajajara Indians). Along Pindaré River, ca 15 km W of Santa Inês. On forest trees, associated with *Orbignya*, 03°30' S, 045°30' W, 31-VIII-1983, Balick, M.J. 1481 (INPA 127516).

Key to *Vanilla* species from Maranhão (modified from Soto Arenas and Dressler 2010)

1. Leaves thin, membranaceous, sometimes chartaceous; inflorescence rachis lax with remote bracts; lip fused to the column only basally, fusion shorter (than 4 mm), column smooth or basally keeled, but devoid of substigmatic hairs; lip without a penicillate callus formed by a tuft of laciniate scales instead *V. mexicana*
- 1'. Leaves thick, coriaceous to fleshy; inflorescence rachis dense with approximate bracts; lip fused to the column up to the stigmatic region, usually larger than 2.5 cm, column having trichomes with soft, thin,

- long bristles on the ventral surface; lip with a penicillate callus, forming a tuft laciniate and retrorse 2
2. Lip yellowish white, infundibuliform, retrorse apex; leaves linear-elliptic *V. bahiana*
- 2'. Lip yellow, flabellate or trilobed; leaves variously shaped, but not linear-elliptic 3
3. Fruits short (ca 3–3.75 cm long); ripe fruits with no aroma *V. palmarum*
- 3'. Fruits long (7.3–30 cm long); ripe fruits with intense aroma 4
4. Leaves 9.5–23 × 3.5–7.6 cm; lip margin undulate-denticulate *V. planifolia*
- 4'. Leaves 20–28 × 7–16 cm; lip margin undulate *V. pompona*

Vanilla bahiana Hoehne, Arq. Bot. Estado São Paulo, 2 (5):108, pl. 43, 1950.

Figure 2

Hemiepiphytic herb, climbing habit, up to 15 m long. Adventitious roots, flat in the portion attached to the phorophyte stem (0.3 cm in diameter × 3.0–4.0 cm in length), one per node, the basal one (i.e., the root closer to the soil and the phorophyte base) being cylindrical and long (0.3 cm in diameter × 50.0–200.0 cm in length). Stem single or branched, 0.7–1.3 cm in diameter, green, thin, longitudinally grooved, cylindrical; internodes 11.3–17.0 cm in length. Leaves green, alternate, 15.0–21.0 × 2.0–3.0 cm, linear-elliptic, fleshy, apex acute. Inflorescence lateral, racemose, starting from the base of leaf, rachis 4.8–13.0 cm in length, multiflora, 4–12 flowers, successive anthesis; peduncle 1.0–1.8 cm in length; floral bracts 0.5–0.9 × 0.5–0.7 cm, oval-lanceolate, apex acute. Resupinate flower; sepals and petals yellow-green; dorsal sepal 0.9–1.3 × 7.5–7.8 cm, oblanceolate, concave near apex, apex acute, a little narrower than the apex of the lateral sepals; lateral sepals 1.1–1.5 × 8.1–8.5 cm, oblanceolate, concave near apex, apex acute, a little wider than the apex of the dorsal sepal; petals 0.7–0.9 × 7.3–7.6 cm, oblanceolate, apex acute; lip 2.0–2.2 × 6.4–6.9 cm, yellowish white, infundibuliform, retrorse apex, fused 2/3 of the column side, deepest near the middle, axially grooved on the lower surface, internally white with orange and longitudinal stripes to the apex, penicillate callus, retrorse, 0.4–0.5 × 0.5–0.8 cm; column thin, 0.5 × 5.3–5.5 cm, curved downward near the stigmatic region (slightly sigmoid), with soft and short trichomes; ovary with pedicel, 0.5 × 3.7–4.0 cm, light green, without notable longitudinal lines. Fruit 1.0–1.2 × 6.5–7.5 cm, green when unripe, elongated, cylindrical, slightly curved, dark brown when ripe.

Vanilla pompona Schiede, Linnaea, 4:573–574, 1829.

Figure 3

Hemiepiphytic herb, climbing habit, up to 11 m long. Adventitious roots, flat in the portion attached to the phorophyte stem (0.3–0.5 cm in diameter × 3.0–7.0 cm in length), one per node, the basal one (i.e., the root closer

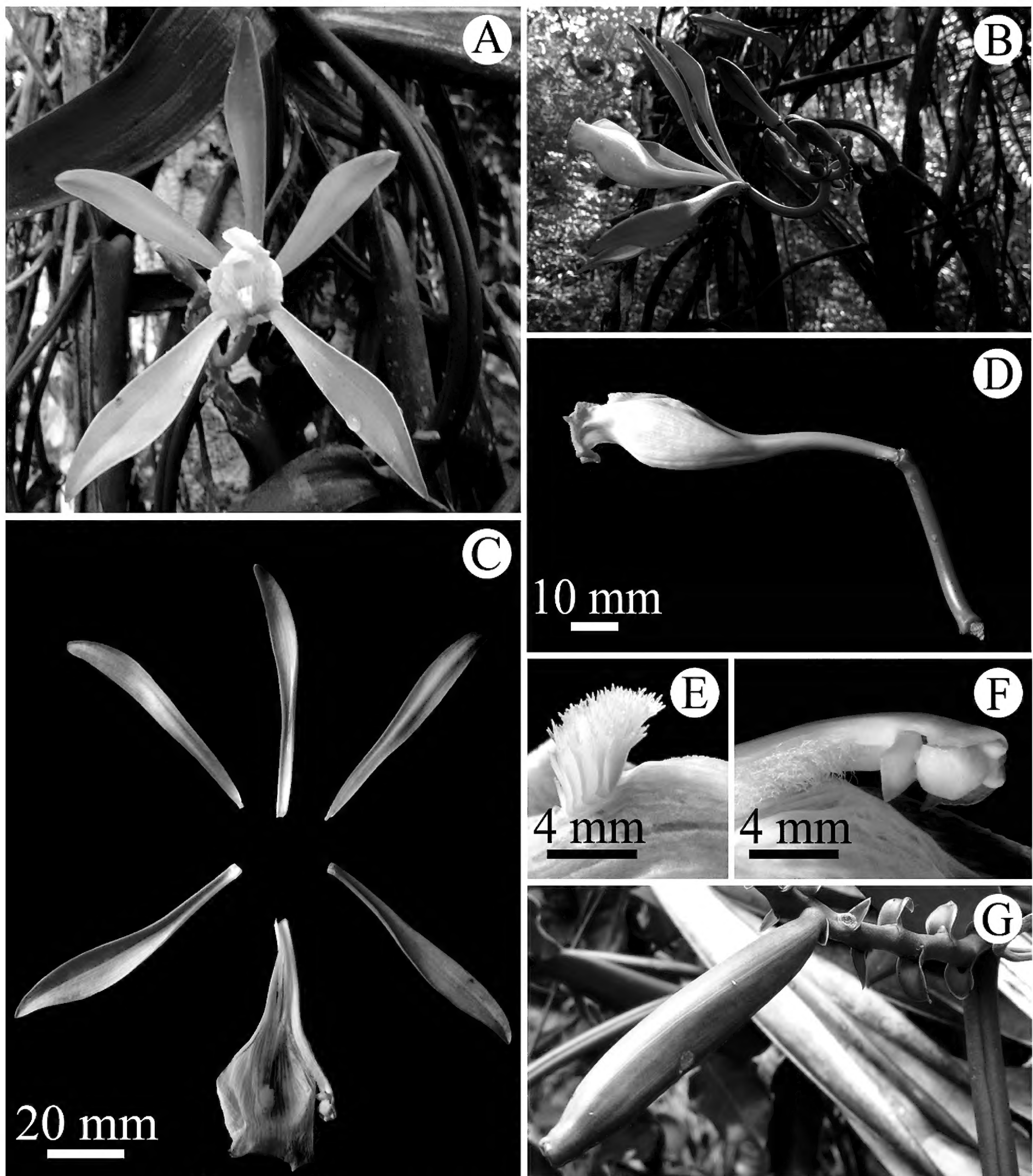


Figure 2. *Vanilla bahiana* Hoehne. **A.** Part of plant with flower in front view. **B.** Flower in side view. **C.** Dissected perianth. **D.** Lip and ovary in side view. **E.** Penicillate callus on the lip in side view. **F.** Part of the column in ventral view showing the rostellum and part of the distended lip. **G.** Fruit.

to the soil and the phorophyte base) being cylindrical and long (0.2–0.3 cm in diameter \times 40.0–220.0 cm in length). Stem rarely branched, 1.2–3.0 cm in diameter, green, smooth, fleshy, cylindrical; internodes 9.9–12.0 cm in length. Leaves green, alternate, 17.0–17.8 \times 6.4–8.0 cm, oblong, fleshy–coriaceous, apex acute. Inflorescence lateral, racemose, starting from the base of leaf, rachis 4.0–5.0 cm in length, multiflora, 5–11 flowers, successive anthesis; peduncle 0.8–1.1 cm in length; floral bracts 1.0–1.3 \times 1.0–1.4 cm, concave, oval to oval-lanceolate, apex acute. Resupinate flower, sepals and petals yellow;

low; dorsal sepal 0.8–1.4 \times 7.5–9.8 cm, oblanceolate, slightly concave, apex obtuse, larger than lateral sepals; lateral sepals 0.7–1.2 \times 6.7–8.5 cm, oblanceolate, slightly concave, apex obtuse, smaller than dorsal sepal; petals 0.8–1.3 \times 6.5–9.2 cm, oblanceolate; lip 2.4–3.0 \times 6.7–8.0 cm, yellow, infundibuliform, apex fairly reflexed, deepest near the middle, axially grooved on the lower surface, with margin fused to the column along to the basal half (3.0–4.5 cm), penicillate callus, retrorse, 0.5 \times 0.5–1.0 cm; column thin, 0.3–0.4 \times 6.3–6.5 cm, curved downward at the mid region (slightly sigmoid), with soft, thin,

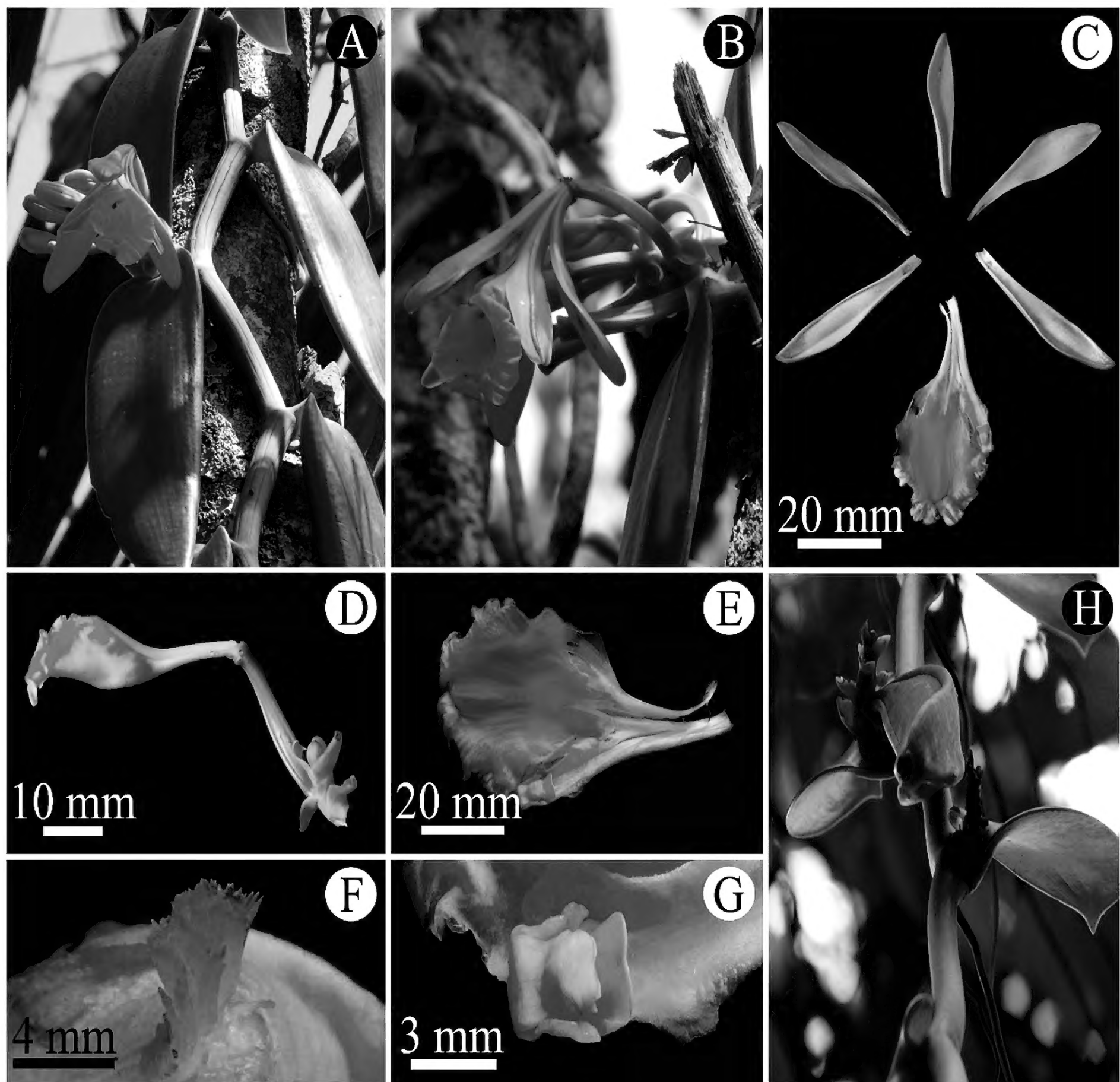


Figure 3. *Vanilla pompona* Schiede. **A.** Habit and flower in front view. **B.** Flower in side view. **C.** Dissected perianth. **D.** Lip, ovary, and part of an inflorescence in side view. **E.** Distended lip. **F.** Penicillate callus on the lip in side view. **G.** Column apical portion in ventral view. **H.** Fruit.

long trichomes and bristles on the ventral surface; ovary with pedicel, $0.7\text{--}0.8 \times 3.8\text{--}5.6$ cm, light green, triangular, twisted, with three longitudinal lines. Fruit $1.8\text{--}2.5 \times 10.0\text{--}13.0$ cm, elongated, tetrahedral, slightly curved, green when unripe and dark brown when ripe.

Note. In the SpeciesLink database there is a citation for a collection of *V. pompona* from state of Maranhão [Balick, M.J. 1481 (INPA 127516)]. The cited collection is a sterile specimen and after studying it we concluded that it is not possible to confidently assign it to *V. pompona*. In addition, the leaf form of this sterile specimen is lanceolate, whereas in *V. pompona* it is oblong. Moreover, the fact that it was collected associated with *Orbignya* (babassu palm) and is considered common in this place, suggests that it might be *Vanilla palmarum* (Salzm. Ex Lindl.) Lindl., an epiphytic species commonly associated with babassu palm in Maranhão.

Discussion

Vanilla bahiana and *V. pompona* were collected in the study areas (Fig. 1), vegetating on the phorophytes: mango tree (*Mangifera indica* L., Anacardiaceae), babassu palm (*Attalea speciosa* Mart. ex Spreng, Arecaceae), and *Mimosa* sp. (Fabaceae).

Vanilla bahiana was found in gallery forests belonging to the Brazilian Cerrado of 2 localities of the municipality of Caxias: Inhamum Municipal Environmental Protection Area (Inhamum stream) (Neres and Conceição 2010) and in the Spring town (Fig. 1). *V. pompona* was observed and collected only in a locality of Caxias: Inhamum Municipal Environmental Protection Area (APA Inhamum), also in gallery forest (Inhamum stream) (Fig. 1) belonging to the Brazilian Cerrado (Neres and Conceição 2010), coexisting with *V. bahiana*.

Vanilla bahiana is a native species endemic to Brazil

Table 1. A comparison between *Vanilla bahiana* and *Vanilla pompona*.

Feature	<i>Vanilla bahiana</i>	<i>Vanilla pompona</i>
Leaf blade shape	Linear-elliptic	Oblong
Stem size and shape	Ca. 15 m long; thin, cylindrical, ramified; longitudinally grooved	Ca. 11 m long; stem fleshy, smooth, rarely branched
Number of flowers	4–12	5–11
Floral bract size	0.5–0.9 × 0.5–0.7 cm	1.0–1.4 × 1.0–1.3 cm
Sepal and petal color	Yellowish-green	Yellow
Lateral sepal size	1.1–1.5 × 8.1–8.5 cm	0.7–1.2 × 6.7–8.5 cm
Petal size	0.7–0.9 × 7.3–7.6 cm	0.8–1.3 × 6.5–9.2 cm
Column size	0.5 × 5.3–5.5 cm	0.3–0.4 × 6.3–6.5 cm
Labellum size	2.0–2.2 × 6.4–6.9 cm	2.4–3.0 × 6.7–8.0 cm
Flowering season	September to January	July to August

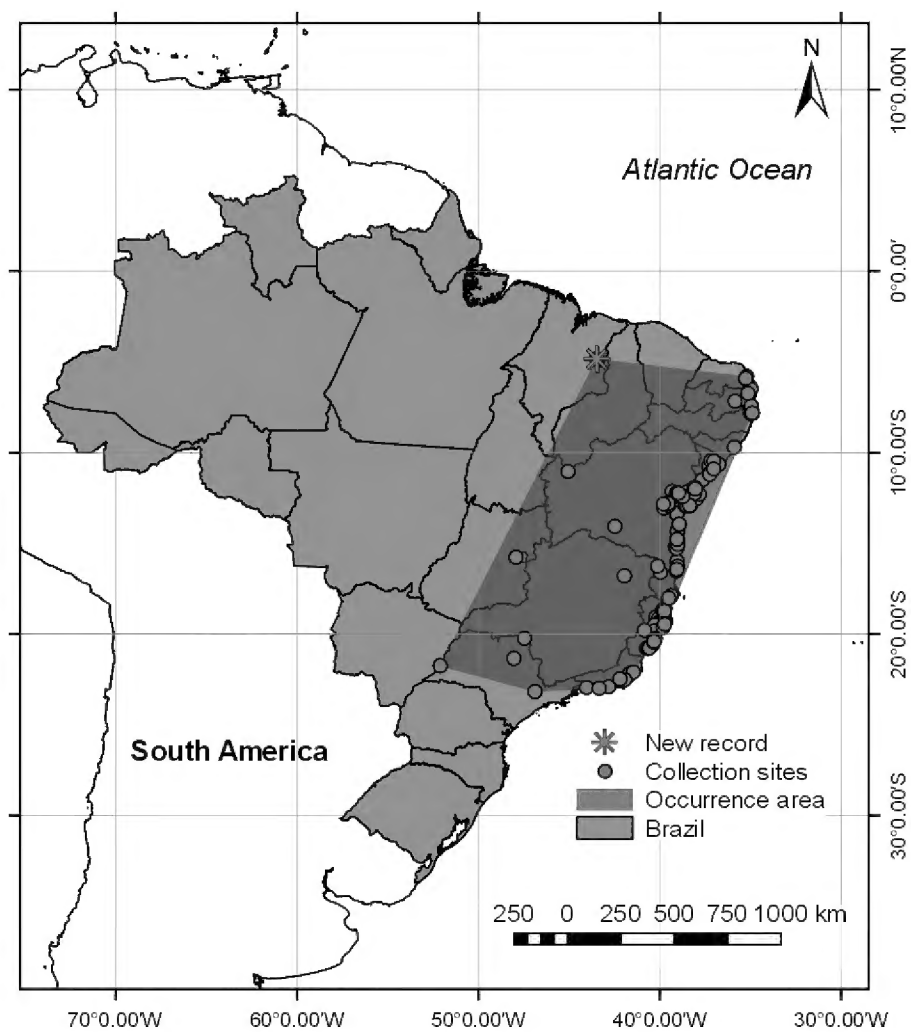


Figure 4. Geographical distribution area of *Vanilla bahiana* in the Brazilian territory (2017).

and the species was described from the state of Bahia (Hoehne 1950). The species was later reported from other northeastern Brazilian states (Sergipe, Alagoas, Pernambuco, Paraíba and Rio Grande do Norte), as well as in midwestern (Federal District) and southeastern Brazil (Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo states) (Brazilian Flora 2017).

Vanilla pompona occurs in Brazil, Colombia, Ecuador, Mexico, and Nicaragua (Soto Arenas and Cribb 2010). In Brazil, the species occurs in states from northern (Amazonas, Amapá, Rondônia, and Tocantins), midwestern (Goiás and Mato Grosso), southeastern (Minas Gerais), and northeastern Brazil (Pernambuco and Paraíba) (Brazilian Flora 2017).

Vanilla bahiana and *V. pompona*, based in molecular and morphological data are both placed in the subgenus *Xanata* Soto Arenas & Cribb, with *V. bahiana* informally placed in the *V. planifolia* group and *V. pompona* group, respectively (Soto-Arenas and Cribb 2010). The 2 species can be differentiated by morphological characters such as leaf shape and flower morphology and color

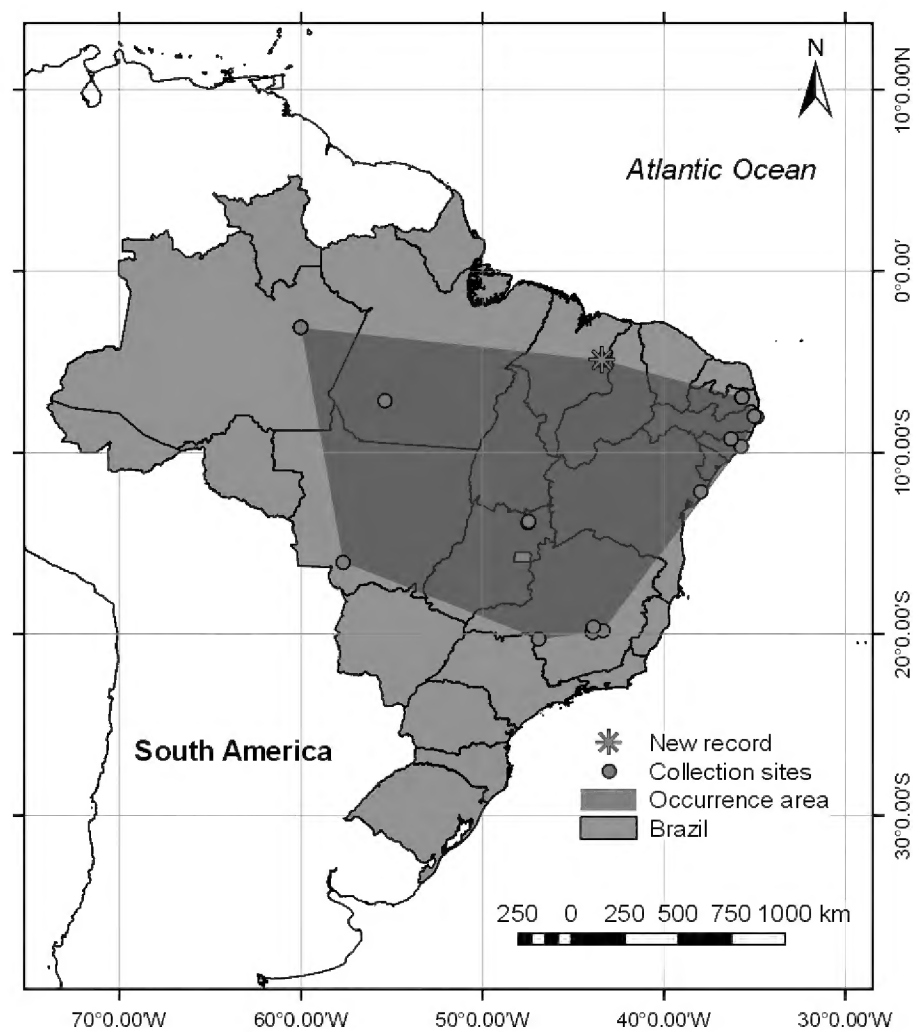


Figure 5. Geographical distribution area of *Vanilla pompona* in the Brazilian territory (2017).

(Table 1). Furthermore, the species have different flowering seasons. *Vanilla bahiana* blooms from September to January, while blooming of *V. pompona* occurs from July to August. Another field observation was that *V. bahiana* tolerates environments in the transition to dry areas, while *V. pompona* tends to occur in marshy areas.

This is the first report of *Vanilla bahiana* and *Vanilla pompona* to the flora of Maranhão state, Brazil. These 2 new records extend the distribution of *V. bahiana* to 707 km north from the nearest collection site (locality: Primavera, Formosa do Rio Preto municipality, Bahia state, Brazil) and 869 km to the west (Ipuarana Farm, Lagoa Seca municipality, Paraíba state, Brazil); and the occurrence of *V. pompona* to 1348 km west from the nearest collection site (Curuá Falls, Novo Progresso municipality, Pará state, Brazil), 886 km to the west (Areia municipality, Paraíba state, Brazil) and 1093 km to the north (Chapada dos Veadeiros, Cavalcante municipality, Goiás state, Brazil).

Using 178 collections of *V. bahiana* representing 150 localities, including the new record, an extent of

occurrence (EOO) of 2,174,496.018 km² and an area of occupancy (AOO) of 452 km² (Fig. 4) was obtained. Based on 26 collections of *V. pompona* representing 18 localities, we obtained an extent of occurrence (EOO) of 3,546,277 km² and an area of occupancy (AOO) of 64 km² (Fig. 5). Although both species are widespread across their distribution, most populations are reported from the Atlantic forest, where habitats are severely fragmented, and the suitable habitats may experience decline in quality due to further deforestation, which may in turn affect the survival of the species. Therefore, *V. bahiana* and *V. pompona* are both assigned a preliminary status of “Endangered” under criteria ENB2ab(ii).

Thus, our results illustrate that more collection efforts are needed to increase knowledge on orchids and their distribution by reducing geographical gaps (BFG 2015, Brazilian Flora 2017).

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Authors' Contributions

MSO, EOS, and AWCF collected and photographed the plants. EOS, AWCF and DSC wrote the text. AWCF and ERP identified the specimens. MSO and EAEG revised herbarium collections. ERP and EAEG revised the text.

References

- BFG (The Brazil Flora Group) (2015) Growing knowledge: an overview of Seed Plant diversity in Brazil. *Rodriguésia* 66 (4): 1085–1113. <https://doi.org/10.1590/2175-7860201566411>
- Brazilian Flora (2017). Jardim Botânico do Rio de Janeiro. <http://floradobrasil.jbrj.gov.br/reflora/listaBrasil/FichaPublicaTaxonUC/FichaPublicaTaxonUC.do?id=FB117>. Accessed on: 2017-3-17.
- Bory S, Brown SC, Duval MF, Besse P (2010) Evolutionary processes and diversification in the genus *Vanilla*. In: Odoux E, Grisoni M (Eds) *Vanilla*. CRC Press, Boca Raton, 15–28.
- Cameron KM (2003) Vanilloideae. In: Pridgeon A, Cribb P, Chase M, Rasmussen F (Eds.) *Genera orchidacearum*, Vol. 3. Oxford University, Oxford, 281–334.
- Chase MW, Cameron KM, Freudenstein JV, Pridgeon AM, Salazar G, Van den Berg C, Schuitman A (2015) An update classification of Orchidaceae. *Botanical Journal of the Linnean Society* 177 (2): 151–174. <https://doi.org/10.1111/boj.12234>
- Fraga CN, Couto DR, Pansarin ER (2017) Two new species of *Vanilla* (Orchidaceae) in the Brazilian Atlantic Forest. *Phytotaxa* 296: 63–72. <https://doi.org/10.11646/phytotaxa.296.1.4>
- Govaerts R (2014) World Checklist of Orchidaceae. Facilitated by the Royal Botanic Gardens, Kew. <http://apps.kew.org/wcsp/>. Accessed on: 20-03-2017.
- Hoehne FC (1950) Algumas novidades da Flora do Brasil Austro-Oriental de entre Orchidaceas e Convolvulaceas. *Arquivos de Botânica do Estado de São Paulo* 2 (5): 105–110.
- IUCN (2017) IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. <http://www.iucnredlist.org/>. Accessed on: 2017-05-29.
- Neres LP, Conceição GM (2010) Florística e Fitossociologia da Área de Proteção Ambiental Municipal do Inhamum, Caxias, Maranhão, Brasil. *Cadernos de Geociências* 7 (2): 122–130.
- Pabst GFJ, Dungs F (1975) *Orchidaceae Brasiliensis*, Vol. 1. Kurt Schmersow, Hildesheim, 408 pp.
- Pansarin ER, Salatino A, Pansarin LM, Sazima M (2012) Pollination systems in Pogonieae (Orchidaceae: Vanilloideae): A hypothesis of evolution among reward and rewardless flowers. *Flora* 207 (12): 849–861. <https://doi.org/10.1016/j.flora.2012.09.011>
- Pansarin ER, Miranda MR (2016) A new species of *Vanilla* (Orchidaceae: Vanilloideae) from Brazil. *Phytotaxa* 267 (1): 084–088. <https://doi.org/10.11646/phytotaxa.267.1.9>
- Pessoa E, Alves M (2012) Flora da Usina São José, Igarassu, Pernambuco: Orchidaceae. *Rodriguésia* 62 (3): 341–356. <https://doi.org/10.1590/S2175-78602012000200009>
- Pessoa E, Alves M (2015) Synopsis of Orchidaceae from Serra do Urubu: an area of montane forest, Pernambuco State, Brazil. *Hoehnea* 42 (1): 109–133. <https://doi.org/10.1590/2236-8906-35/2014>
- Sanbim A, Chiron GR (2015) Deux nouvelles espèces de *Vanilla* (Orchidaceae) de Guyane française. *Richardiana* 15: 306–316.
- Silva MFF, Silva JBF, Feiler JM (1999) Orchidaceas do Estado do Maranhão, Brasil. *Acta Amazonica* 29 (3): 381–393. <https://doi.org/10.1590/1809-43921999293393>
- Soto-Arenas MA (2003) *Vanilla*. In: Pridgeon AM, Cribb PJ, Chase MW, Rasmussen FN (Eds) *Genera Orchidacearum: Orchidoideae*. Oxford University Press, Oxford, 321–334.
- Soto-Arenas MA, Cribb P (2010) A new infrageneric classification and synopsis of the genus *Vanilla* Plum. ex. Mill. (Orchidaceae: Vanillinae). *Lankesteriana* 9 (3): 355–398. <https://doi.org/10.15517/lank.v0i0.12071>
- Soto-Arenas MA, Dressler RL (2010) A revision of the Mexican and Central American species of *Vanilla* Plumier ex Miller with a characterization of their ITS region of the nuclear ribosomal DNA. *Lankesteriana* 9 (3): 285–354. <https://doi.org/10.15517/lank.v0i0.12065>
- SpeciesLink (2017) Base de dados eletrônica. <http://www.splink.org.br>. Accessed on: 2017-2-9.
- Thiers B (2017) Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff. New York Botanical Garden's Virtual Herbarium. <https://sweetgum.nybg.org/ih/>. Accessed on: 2017-3-22.
- Tropicos (2017) Missouri Botanical Garden. <http://www.tropicos.org/>. Accessed on: 2016-12-9.